Message

**From**: McKaughan, Colleen [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=F37EB6F19D09495190CAD9CCA9EE8F62-CMCKAUGH]
**Sent**: 6/15/2016 10:36:22 PM
**To**: Eugenia Quintana [eugeniaquintana@navajo-nsn.gov]; LIMAYE, VIJAY [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=3301d351c2114a5ea5ff556829d8f988-VLIMAYE]; Gaurav Rajen [rajenwnr@gmail.com]; Raju Bisht [rbisht@navajo-nsn.gov]; Michael Z. King [mzking@navajo-nsn.gov]; Tennille B. Begay [tbbegay@navajo-nsn.gov]
**CC**: YOSHIMURA, GWEN [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=074bd8abec8f4c45a4640e7f772456b4-GYOSHIMU]; Bohning, Scott [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c00bdc10ca564ae982aa105d4c1b32c5-SBOHNING]
**Subject**: RE: Requesting letter for July 1 SO2 DRR deadline

Thanks, Eugenia!

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**From:** Eugenia Quintana [mailto:eugeniaquintana@navajo-nsn.gov]
**Sent:** Wednesday, June 15, 2016 3:29 PM
**To:** LIMAYE, VIJAY <Limaye.Vijay@epa.gov>; Gaurav Rajen <rajenwnr@gmail.com>; Raju Bisht <rbisht@navajo-nsn.gov>; Michael Z. King <mzking@navajo-nsn.gov>; Tennille B. Begay <tbbegay@navajo-nsn.gov>
**Cc:** McKaughan, Colleen <McKaughan.Colleen@epa.gov>; YOSHIMURA, GWEN <Yoshimura.Gwen@epa.gov>; Bohning, Scott <Bohning.Scott@epa.gov>
**Subject:** RE: Requesting letter for July 1 SO2 DRR deadline

Hello.

Thank you for the information.

We do have a draft letter being finalized on this matter.

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**From:** LIMAYE, VIJAY <Limaye.Vijay@epa.gov>
**Sent:** Wednesday, June 15, 2016 2:20 PM
**To:** Gaurav Rajen; Raju Bisht; Michael Z. King; Eugenia Quintana; Tennille B. Begay
**Cc:** McKaughan, Colleen; YOSHIMURA, GWEN; Bohning, Scott
**Subject:** Requesting letter for July 1 SO2 DRR deadline

Hi Eugenia,
Just to follow up briefly on the upcoming 7/1/2016 SO2 DRR deadline, we recently learned that EPA intends to post the correspondence conveying how the air agencies will be characterizing their DRR sources, similar to how the source list letters & responses were posted here: https://www.epa.gov/airquality/sulfurdioxide/drr.html

In light of this, and to satisfy 40 CFR 51.1203(b), we believe that a letter from NNEPA to EPA Region 9 acting RA Alexis Strauss (cc'ing Doris Lo, Gwen Yoshimura, Scott Bohning, and myself) listing the two DRR sources for Navajo Nation and indicating that they will both be characterized through modeling is appropriate. We can continue to work through the details of the modeling protocol after 7/1, but it would be helpful for us to have the letter by then.

Please let me know if you have any questions, and thanks for all of your work on this effort!
Best,
Vijay

**Vijay Limaye, Ph.D.**

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**From:** Gaurav Rajen [mailto:rajenwnr@gmail.com]
**Sent:** Monday, June 13, 2016 12:40 PM
**To:** Bohning, Scott <Bohning.Scott@epa.gov>
**Cc:** McKaughan, Colleen <McKaughan.Colleen@epa.gov>; Raju Bisht <rbisht@navajo-nsn.gov>; Michael Z. King <mzking@navajo-nsn.gov>; eugeniaquintana@navajo-nsn.gov; Tennille B. Begay <tbbegay@navajo-nsn.gov>; Withey, Charlotte <Withey.Charlotte@epa.gov>; Chen, Eugene <Chen.Eugene@epa.gov>; YOSHIMURA, GWEN <Yoshimura.Gwen@epa.gov>; LIMAYE, VIJAY <Limaye.Vijay@epa.gov>
**Subject:** A very balanced approach and eminently fair and reasonable

Thanks Scott:

We all appreciate your responses. These responses will help in framing the letters we send this week to FCPP and NGS, which I am currently drafting. There is an electronic Appendix in the FCPP's EIS that contains all the needed input files; hopefully, NGS will also provide these. Mike King had previously worked with Lakes Environmental while doing his research at Purdue on NOx and SOx transport in the Four Corners region; and they (Lakes Environmental), too, have input files set up.

Your approach seems very balanced, fair, and reasonable.

My take-aways are - 1) the July 1 deadline is met with our having sent in a draft protocol; we will finalize this in coming weeks; 2) we will use federally enforceable limits (from FIPs etc.) and could really benefit from EPA's help in making sure we have the right estimates to set the DRR-specified source terms; 3) we will do a parametric study on the effects of higher emissions, flow rates and changed temperatures to bound any future modeling work and determine if the EIS studies are truly conservative; 4) using the existing AERMET and AERMOD input data files from the existing EISs we will re-run the AERMOD models (if deemed required by (3) above) - re-running to be done using the existing met data, geophysical domain, receptor grids, etc., while changing the source emissions input data based on (2) above.

Best regards,

Gaurav

PS: I am fairly new at this - do we (as a team) have the correct numbers to use for SO2 emissions in lbs/hr that would be the federally enforceable limit in effect before January 2017? I went through several documents and came up with what seemed to be the limits. The EIS numbers are clearly stated and appear higher than the limits being enforced. The right numbers to use for the DRR limits will help in my doing an accurate parametric study as in (3) above.

On Mon, Jun 13, 2016 at 1:10 PM, Bohning, Scott <Bohning.Scott@epa.gov> wrote:

> Guarav -
>
> Thanks for the reply... I have to work on some other things today, hopefully we can discuss more Thursday 6/16 call, but here is a response for now.
>
> - It does makes sense to quantitatively assess how much the emission rates change the stack temperature and exit velocity. That helps with the qualitative arguments about how the model reacts and the conservativeness of the EIS

modeling. That stack parameter assessment would also help with just going ahead and remodeling. (Assuming we can get the original AERMOD input files and the AERMET output & hopefully input files, that would just be a matter of changing the stack parameter input lines to match what we think they are; changing either a few emission lines to reflect allowable emissions or a lot of emission lines to reflect actual emissions; and running the program. Avoids qualitative arguments on stack effects, ADJ_U* option, AERMOD version.)

- SO2 DRR says to use actual emissions of recent three year period, e.g. 2012-2014 or 2013-2015; or, allowable emissions reflecting federally enforceable emission limits in effect before Jan. 2017. It is not clear to us that the emission rates you stated are the appropriate ones to use for DRR modeling and/or to compare to the EIS; those would need to be spelled out more. (Charlotte noted that FCPP Consent Decree 90% control is not relative to the existing allowable emissions, but instead is relative to other assumptions.)

- On what I think you suggested in 6/10 email, re-running model later since already periodically required: that is not necessarily required under the DRR but instead is just discretionary, so we don't think the remodeling later should substitute for modeling now (if we find that it is needed due to EIS modeling not enough or not allowed to be substituted).

- Scott B.

**From:** Gaurav Rajen [mailto:rajenwnr@gmail.com]
**Sent:** Monday, June 13, 2016 11:00 AM
**To:** Bohning, Scott <Bohning.Scott@epa.gov>
**Cc:** McKaughan, Colleen <McKaughan.Colleen@epa.gov>; Raju Bisht <rbisht@navajo-nsn.gov>; Michael Z. King <mzking@navajo-nsn.gov>; eugeniaquintana@navajo-nsn.gov; Tennille B. Begay <tbbegay@navajo-nsn.gov>; Withey, Charlotte <Withey.Charlotte@epa.gov>
**Subject:** Further clarifications and many thanks again Re: AERMOD model approaches regarding plume lofting etc.

Dear Scott:

Many thanks for your very helpful and valuable exchanges. It would be good to keep this exchange as informative as possible so we can have as productive a call on Thursday as possible. We all appreciate your help and that of others at the EPA Region 9 very, very much.

I apologize for being unclear - the way I see this is as follows: for selecting the source terms, the DRR does not solely specify a set of years alone - i.e. the past three years; it also specifies that a federally enforceable limit should set the source term - in our case the FIPs and the operating permits. The Table I sent you (re-pasted below) gives the lbs/hr of SO2 assumed in the EISs and what the DRR would require. As you see below, the DRR would require 1722 and 1790 lbs/hr for the NGS and FCPP respectively. The EISs use 2245 lbs/hr and 2816 lbs/hr respectively. The source terms are higher and should lead to higher levels at the maximally-impacted receptor locations. What I was pointing out is that the temperatures will not change appreciably - however, higher SO2 content in lbs/hr implies higher coal burning rates (though one could also assume higher sulfur content, this content having a maximum allowable being set by the FIP and permits we have to assume higher quantities of coal being burned) which would imply higher gas exit velocities. Therefore, one would have to deal with the possibility of partial plume entry into the Stable Boundary Layer out of the Convective Boundary Layer and later re-entry and the possibility that the higher source emission rate is not automatically conservativen at the maximally-impacted loactions. There are some non-dimensional numbers (Reynold's number, Rayleigh number, Peclet number, Grashof number, etc.) that help us determine which effects predominate. Given the ranges we are dealing with, we can easily show that the higher source terms lead to higher levels at the maximally-impacted receptor locations even with higher stack exit velocities (that are associated with higher emission rates). Perhaps I have misunderstood these issues and am happy to be corrected.

Given the conservative assumptions inherent in the higher source terms used (see table below), I am suggesting that we hold off on re-running the models till we can build a local capability using our existing personnel and resources (e.g. Mike King has tremendous knowledge of modeling and fate and transport, he will be sending you a set of slides of his research at Purdue that you will find informative) and local Navajo colleges that have environmental programs. Getting the resources earmarked is also important and may be best done with more time available. For example, we could seek funding and assistance from EPA HQ and EPA research laboratories (in the Research Triangle Park for instance) - they may like the concept of building local Navajo capability using Navajo colleges to re-run the models. We always have the fall-back option of re-running with the help of the FCPP and the NGS and consultants, such as AECOM.

It just seems to me that as we have existing models and results that use higher conservative source terms and show NAAQS attainment, the fact that we will re-run again as required by the DRR (given the fact that the modeled results are within the %difference to the standards for which the DRR specifies periodic re-runs), we may have more time available to develop local capabilities. So, for the January of 2017 deadline we use the existing model results and further state that the models will be re-run as required by the DRR within a specified time-frame. Just a thought for consideration - again, using the existing modeled results seems justified as the source terms are higher than required by the DRR.

It is good to know that the draft protocol has allowed us to meet our July 1 deadline.

Thank you again,

Gaurav Rajen

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Appendix B
B 1.0 Comparisons of input data required by the DRR and used in the EISs (source emissions, stack velocities, temperatures, beta versions of software to convert meteorological low-wind speed data into planetary boundary layer model parameters, and years selected for meteorological data)

The DRR states that –
…Modeling analyses shall characterize air quality based on either actual SO2 emissions from the most recent 3 years, or on any federally enforceable allowable emission limit or limits established by the air agency or the EPA and that are effective and require compliance by January 13, 2017.

Table B.1 provides the major differences between source emissions used as inputs from the requirements of the DRR and the source emissions factors used in the existing modeling studies done for Environmental Impact Statements by the FCPP and the NGS. Attachments provide copies of the text in the DRR, the Federal Implementation Plans and existing compliance documents that describe the applicable federally enforceable limits; as well as copies of the relevant pages from the EISs.

Table B.1
Source emissions data required by the DRR and used in the EISs

| Plant | NGS | | FCPP | |
|---|---|---|---|---|
| References from which data are derived | DRR | EIS - NGS | DRR | EIS - FCPP |
| Years for which data required/ or basis of quantities used | 2014, 2015, 2016/ federally enforceable limits | As used in EIS – total SO2 from all sources, burners, | 2014, 2015, 2016/ federally enforceable limit | As used in EIS - emission rates from the Units 4 and 5 |

| | | | | |
|---|---|---|---|---|
| | | boilers, mines, on and off-road equipment, emergency generators, etc. | | stack are derived from consideration of actual hourly data, and the current Title V operating permit for FCPP |
| Average SO2 lbs/hr over any 1-hour period | **Approximately 1722 lbs/hr** – derived from 7544 tons/year allowed as a federally enforceable limit in the FIP | **2245 lbs/hr** | **1790 lbs/hr** (from draft FIP and federally enforceable limit – 10% of allowable SO2 generated; drops to 5% (i.e. lesser) in 2018 | **2816 lbs/hr** |

B 2.0 Considerations of stack exit velocities, temperatures and wind speed

When the source term used in the model is varied, there will also be a variation in the assumed stack gases' exit velocity and temperatures of the stack gases. Higher assumed quantities of SO2 released will be linked to higher coal burning rates and hence higher exit stack gas velocities and marginally higher temperatures. The 1-hour concentrations of SO2 at receptor sites in the near-field will be first order dependent on the quantities of SO2 released per hour and with a second to third –order dependence on the exit velocities and temperatures. Higher exit velocities and temperatures may cause some dilution of concentrations at far-field locations, but these effects will be substantially reduced and negligible in comparison to the increase in concentrations from increased SO2 releases in the near-field receptor locations with the maximum SO2 1-hour levels. This leads to the conclusions that the modeling studies conducted in the EISs are conservative in the derived SO2 1-hour concentrations as they use higher SO2 release terms.
Wind speeds will also be critical in determining the concentrations at receptor locations. The FCPP study used a beta version for deriving critical boundary layer parameters for low wind speeds – the following discussion taken from the FCPP EIS describes the rationale for doing so.

[] Low Wind Speed Improvements for AERMOD

In 2010, the results of an evaluation of low wind speed databases for short-range modeling applications were provided to USEPA. The reason for the study was that some of the most restrictive dispersion conditions and the highest model predictions occur under low wind speed conditions, but there had been very little model evaluation for these conditions. The results of the evaluation indicated that in low wind conditions, the friction velocity formulation in AERMOD results in under-predictions of this important planetary boundary layer parameter. There were multiple outcomes of this under-prediction: mechanical mixing heights that were very low (less than 10 meters), very low effective dilution wind speeds, and very low turbulence in stable conditions. In addition, the evaluation study concluded that the minimum lateral turbulence (as parameterized using sigma-v) was too low by at least a factor of 2. After these issues were once again stated at the 10th USEPA Modeling Conference in March 2012, USEPA made some revisions in late 2012 to the AERMOD11 modeling system to correct the model deficiencies in this area. This culminated in USEPA releasing AERMET and AERMOD Versions 12345, which include "beta" options in AERMET for a revised u* formulation under stable conditions and two different low wind speed options in AERMOD. These updates are included in AERMET and AERMOD versions 13350, as well. During the USEPA webinar12 on January 14, 2014, USEPA staff stated that they are generally in favor of the AERMET beta u* option as it is based on peer-reviewed activities.

B 3.0 Issues related to variations in meteorological data used in the models from that suggested in the DRR

In development – we will trend data from our meteorological station in Shiprock to demonstrate that variations between the years of data used in the EIS and the most current trends are not significant.

On Mon, Jun 13, 2016 at 11:07 AM, Bohning, Scott <Bohning.Scott@epa.gov> wrote:

Gaurav -

I do not follow your argument -- cooler stack temperatures for this source would be same for EIS & new modeling, so that in itself would not tend to make EIS conservative... unless I am misunderstanding altogether.... we can talk more on Thurs. 6/16 call if needed on this.

Meanwhile, on your previous email about what issues need to get resolved in a protocol. Ideally a protocol would spell out pretty much the full procedure to be followed in the modeling, though some narrow issues might be left open. The big issue of what current actual emissions or what will be allowable emissions by the end of 2016 (and how those compare to the EIS emissions) is such a key one that we don't think a protocol can really be considered complete without that issue being decided. The related issue of whether new modeling will be done at all is also certainly important enough that it should be set out in the protocol.

However, I would note that July 1st deadline is mainly to get a decision on choice between modeling and monitoring, so as long as there is *some* form of protocol sent in, like the draft one you have already done, that deadline is met. I do not think EPA is issuing official approval of protocols anyway; approval is relative to the actual submitted modeling later on. So we do still have time to figure out emissions and other issues. Although it's good to get as much agreement as possible early on, we agree that we should take the time to get that issue right.

- Scott B.

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"Scott Bohning" <bohning.scott@epa.gov>
U.S. EPA Region 9, AIR-7
415/947-4127 fax-3579

**From:** Gaurav Rajen [mailto:rajenwnr@gmail.com]
**Sent:** Friday, June 10, 2016 3:55 PM
**To:** Bohning, Scott <Bohning.Scott@epa.gov>; McKaughan, Colleen <McKaughan.Colleen@epa.gov>; Raju Bisht <rbisht@navajo-nsn.gov>; Michael Z. King <mzking@navajo-nsn.gov>; eugeniaquintana@navajo-nsn.gov; Tennille B. Begay <tbbegay@navajo-nsn.gov>
**Subject:** AERMOD model approaches regarding plume lofting etc.

Dear Scott:

Just a quick note to share some more thoughts - I have been reviewing the EPA document (AERMOD: DESCRIPTION OF MODEL FORMULATION) available at
- https://www3.epa.gov/scram001/7thconf/aermod/aermod_mfd.pdf

From the document..

"AERMOD is designed to treat the effects on dispersion from vertical variations in wind and turbulence. Consideration of the vertical variation in meteorology is important for properly modeling releases in layers with strong gradients, for capturing the effects of meteorology in layers into which the plume may be vertically dispersing, and to provide a mechanism (in the Convective Boundary Layer, CBL) by which sources that are released into or penetrate into an elevated stable layer can eventually re-enter the mixed layer....

Fundamental to this approach is the concept that **the primary layer of importance, relative to receptor concentration, is the one through which plume material travels directly from source to receptor**."

The model does account for plume lofting and entry out of and back into the CBL Therefore, when the source emissions term changes and the exit gas velocities and temperature change the momentum flux and buoyancy forces also change and the plume averaging over heights could change - I looked closely at the terms used to estimate the stack momentum and buoyancy-induced fluxes in AERMOD. In our case, the stack gases are cooled and scrubbed before exit so temperature increases will be lessened, hence buoyancy-induced fluxes are not appreciably changed. Exit velocities will be higher, but not sufficient to make a major difference in lessening concentrations at the maximum level receptor location. The last sentence in the quote presented above reinforces that the higher source terms used in the EISs lead to higher concentrations - thus the EIS results being conservative in their level estimates. In this regard it is also important to note that AERMOD does not use coupled equations for fate and transport and so the concentration of SO2 does not modify any of the transport parameters, densities, etc.. or change based on chemical reactions. This is why it seems reasonable (given that we can address momentum and buoyancy-induced fluxes at the stack) that higher emission sources will lead to more conservative and higher levels at receptor sites.

As you suggested, it does make sense to run the model again for various reasons that you laid out - I would like you all to consider the re-running of the model to happen at a later date in 2017, allowing us to develop more in-house capability, seek additional supplemental funding, and work with local universities and colleges to develop programs that bring modeling capabilities to the Navajo Nation and train more of our staff and graduate students. Such options could be Navajo Technical University, and Dine College, both of which have environmental programs. If we award a contract to an outside consultant in a rush to meet a deadline we will remain tied to the use of outside consultants. This is something to think through as we progress farther in this effort. Michael King for example has a master's from Purdue in atmospheric physics and has run versions of AERMOD and even more complex fate and transport models. We also have an opportunity when we run AERMOD to use our data to do model validation. Re-running at a later date of course will require us to accept the EIS models' data and results as a first step. Before this decision is made, however, we should first settle on the modeling protocol we will use.

Many thanks for your thoughts on this matter,

Gaurav